



## Regulating wind farms in meshed offshore grids

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# Regulating wind farms in meshed offshore grids

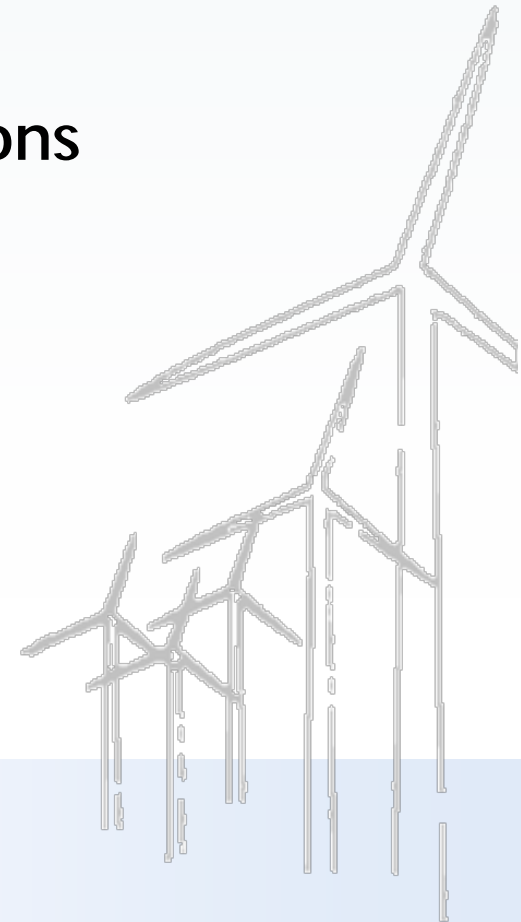
## Market and regulatory framework conditions

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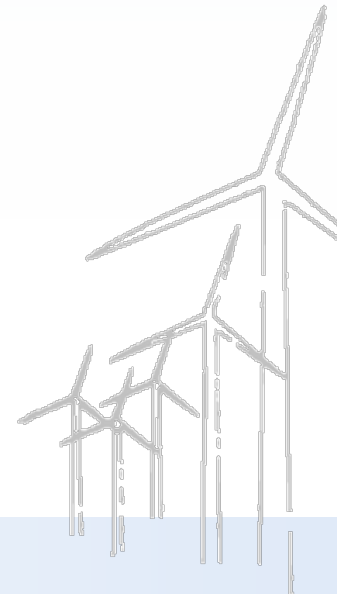
*DTU Management Engineering*  
Energy Systems Analysis

NSON workshop Strathclyde  
7 November 2014



# Agenda    Regulatory framework challenges

- Wind farms at meshed offshore grids
  - EU legislation, bidding zones, congestion and residual transmission capacity
  - Pricing rules?
  
- Market Design:
  - From passive to active dynamic generation / market actors
  
- Main future challenges?



# Regulating future offshore grids



## Research Question

How should production in offshore grids be regulated in terms of

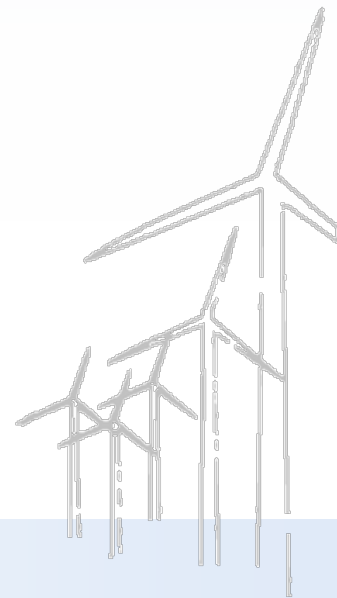
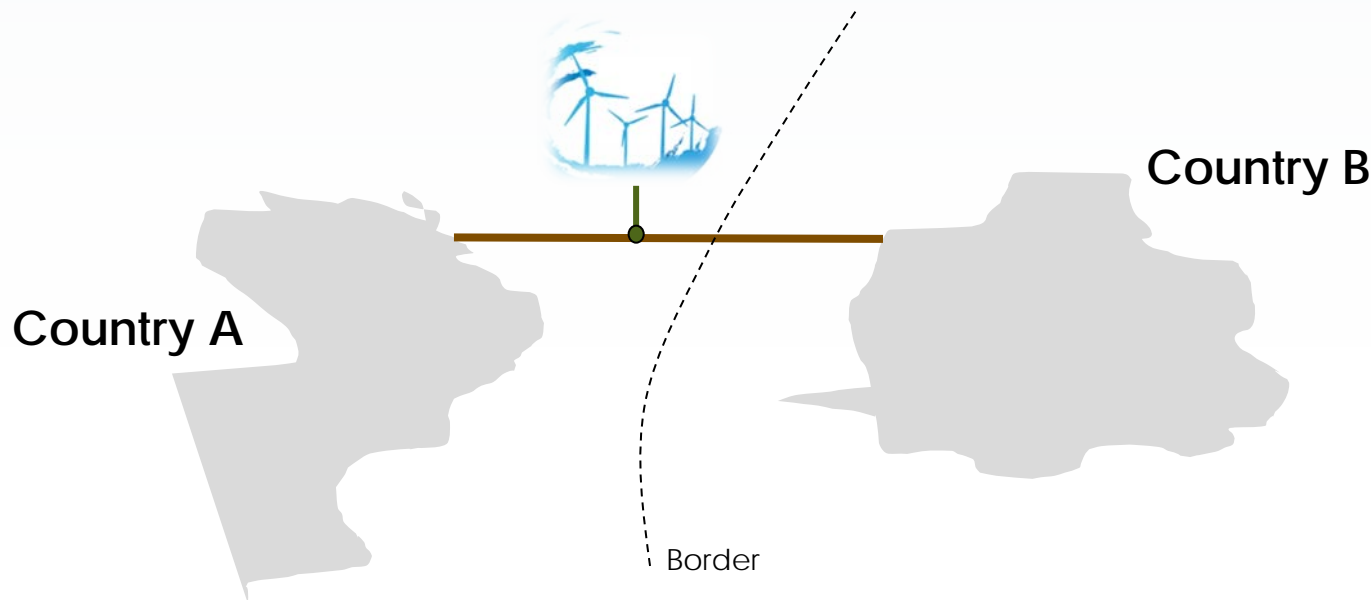
- Currently, offshore wind parks in Europe are single-country approaches
- Future meshed offshore grids will interconnect wind parks and countries
- Current research mostly from a macroscopic perspective

- Market access
- Pricing rules
- Support scheme for RES



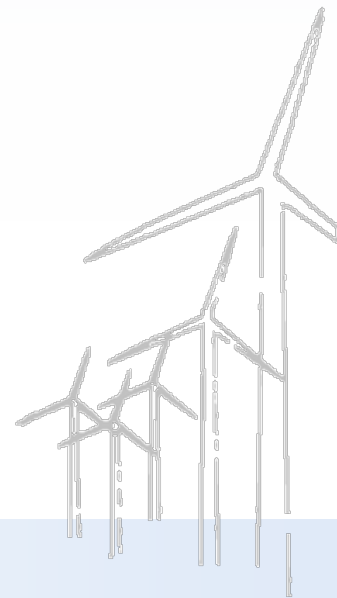
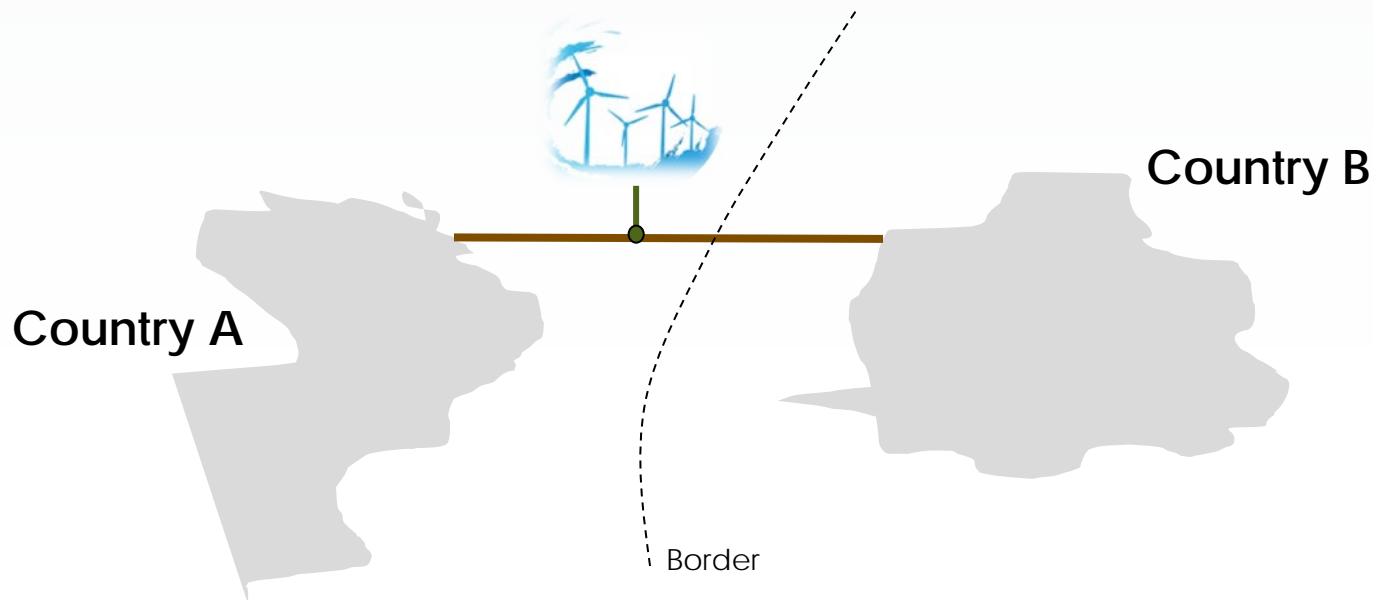
# EU legislation

- **Priority Access** and **Priority Dispatch** for RES-E as per RES Directive (Directive 2009/28/E)
- **Congestion Management Guidelines** and **EU Target Model** as per the 3th Energy Package legislation
  - electricity should flow between price or bidding zones according to price differences.
  - cross-border flows should not be reduced to solve a country's internal congestion



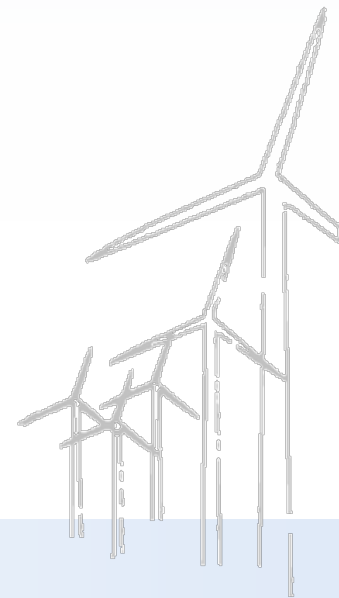
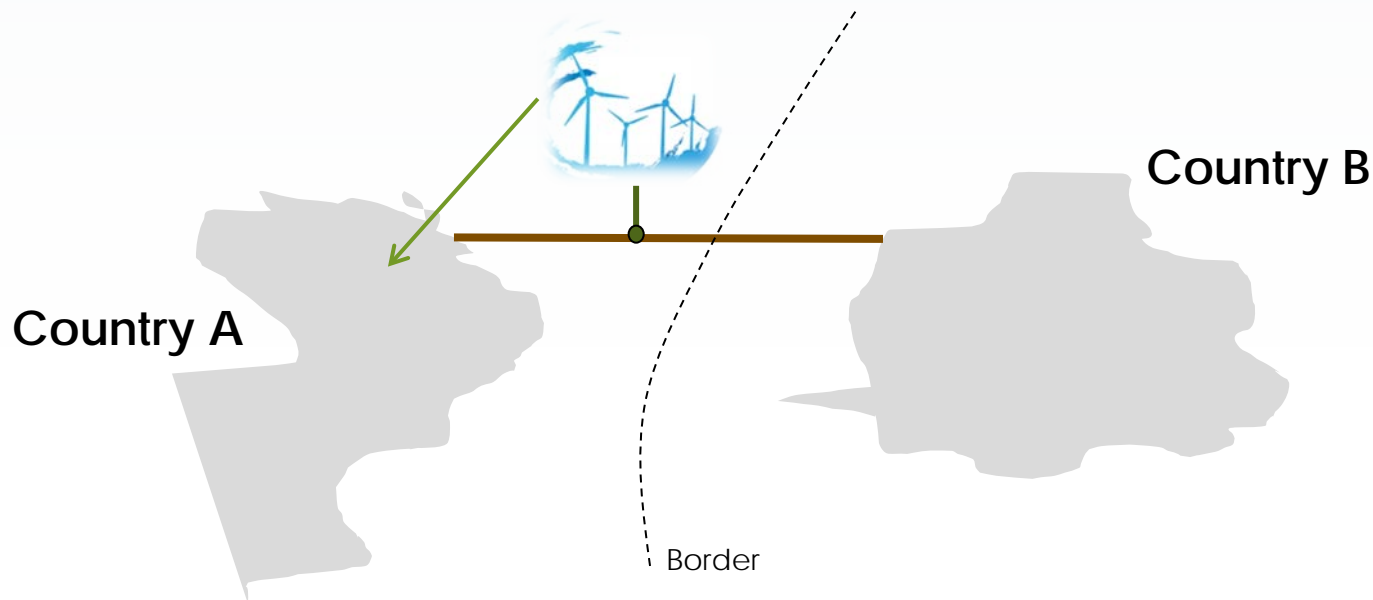
# Bidding zones

- **Home country / Fixed bidding zone:** Wind farm treated as any other trader in zone A
- **Primary access / Floating bidding zone:** May choose its bidding zone
- **Offshore hub / Own bidding zone:** Bidding zone separated from zone A and B




# Home country / Fixed bidding zone

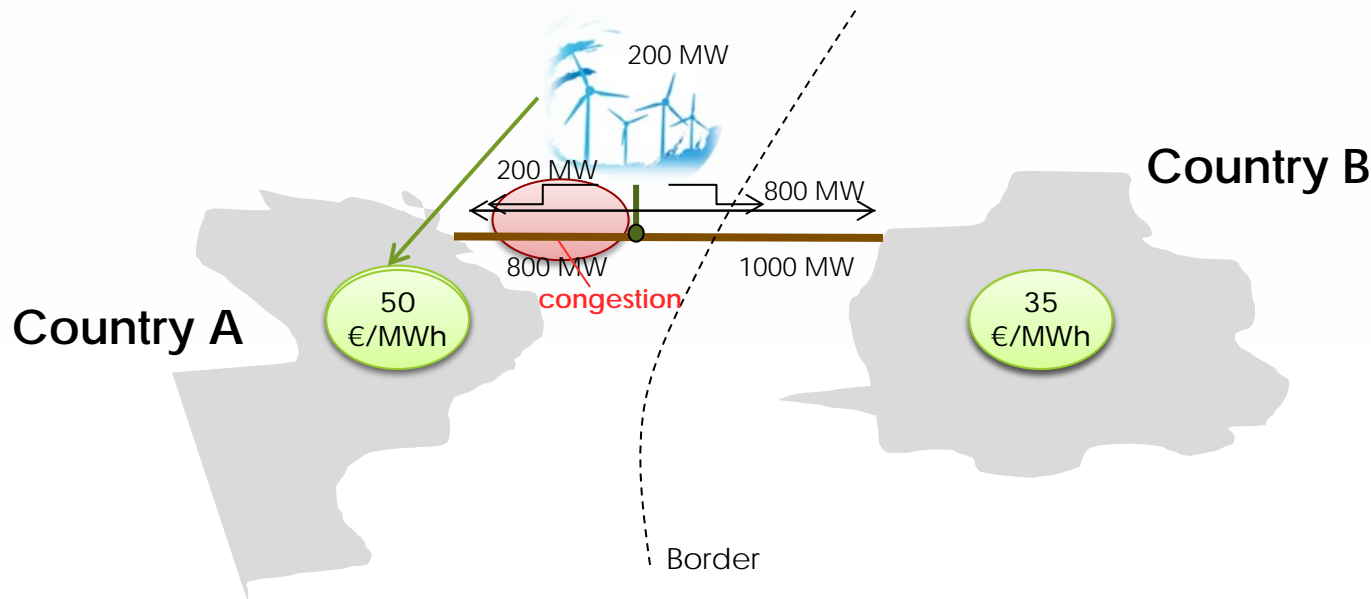
- "Domiciled" in bidding zone A - Treated as any other trader in zone A
- RES support only in home country
- Limited cross-country cooperation
- Residual inter-connector capacities dispatched by TSO



# Fixed bidding zone and congestion

- Flow from A to B
- Flow from B to A  Congestion

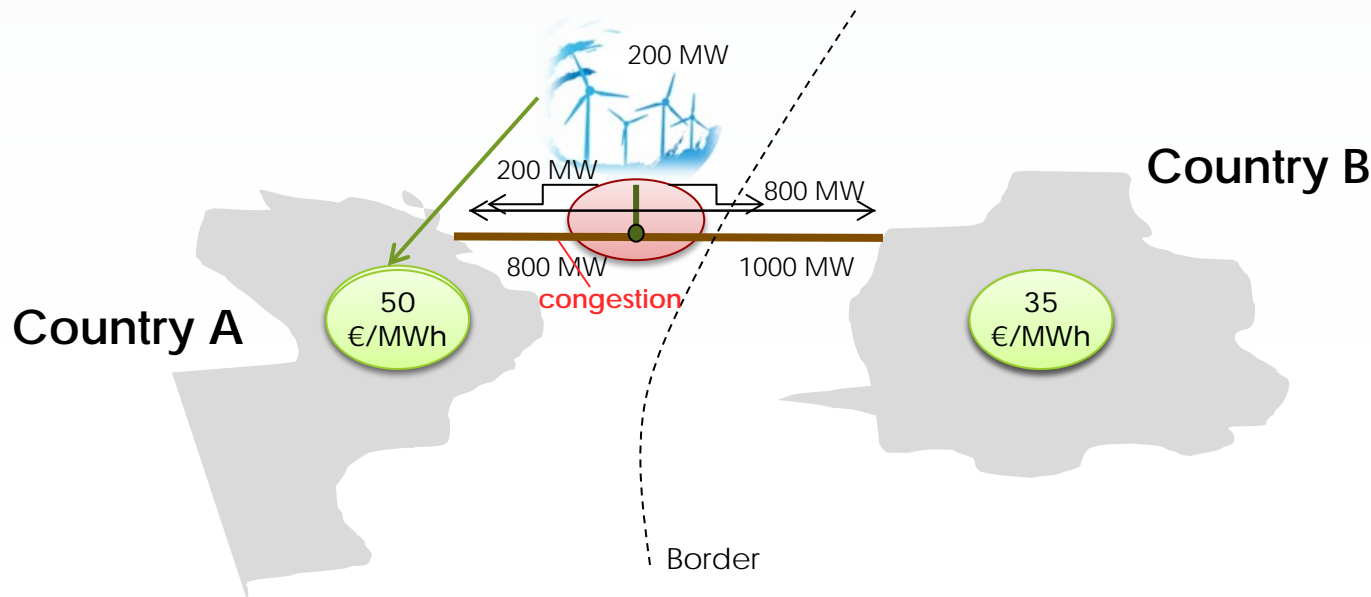
Priority leads to reduction in day-ahead interconnection capacity = **residual capacity** = 800 MW



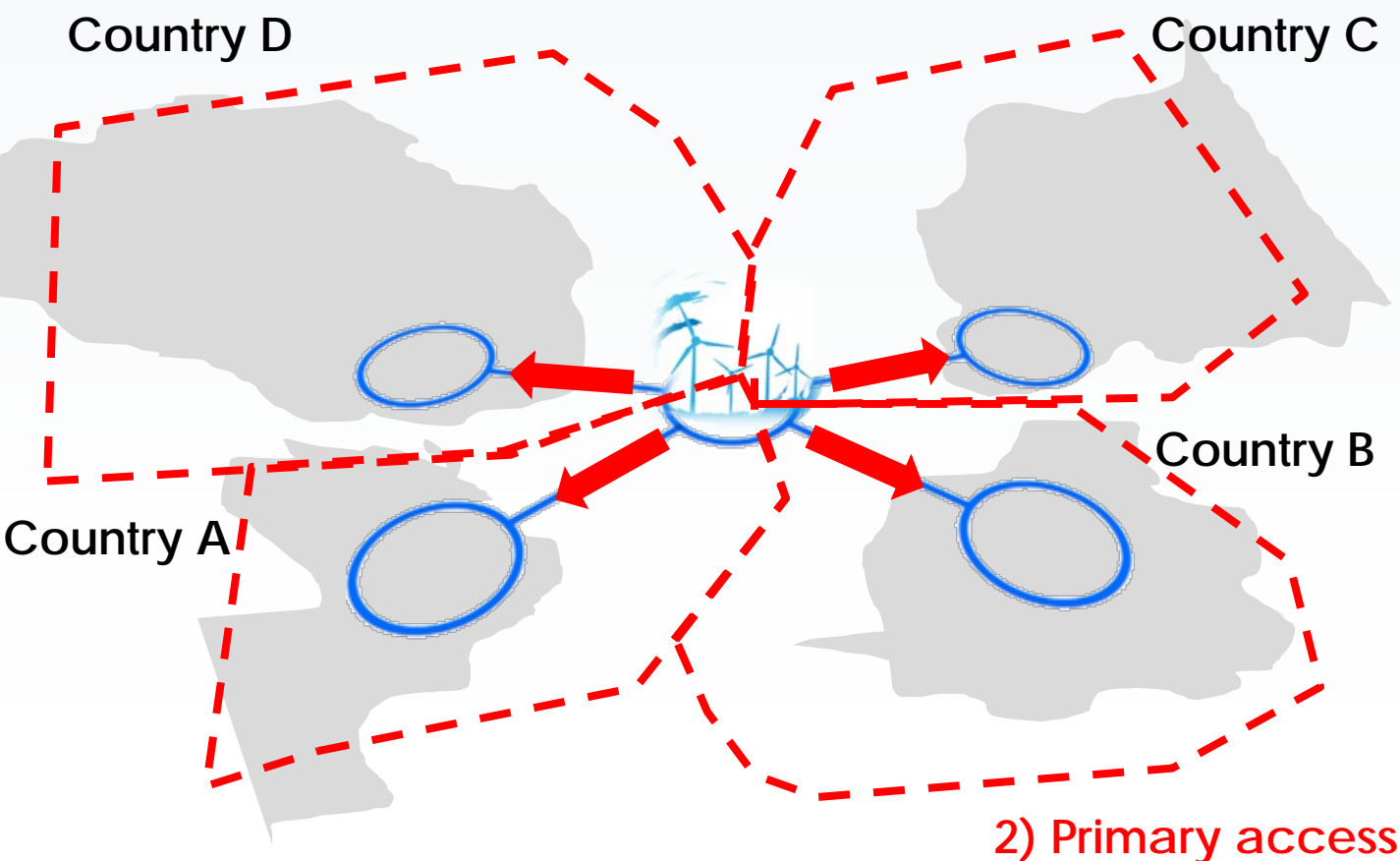


# Pricing rules and congestion compensation

- ✓ Lower price in high price zone       $(+/\div)$  Higher price in low price zone
- Only residual transmission capacity is dispatched
  - Compensation to low price country? Of 200 MW or ???
  - Always the lower price? The high price zone buys **all** capacity from low price zone?
- Who should pay? Subsidy to wind in order to displace conventional emitting power - not to increase export



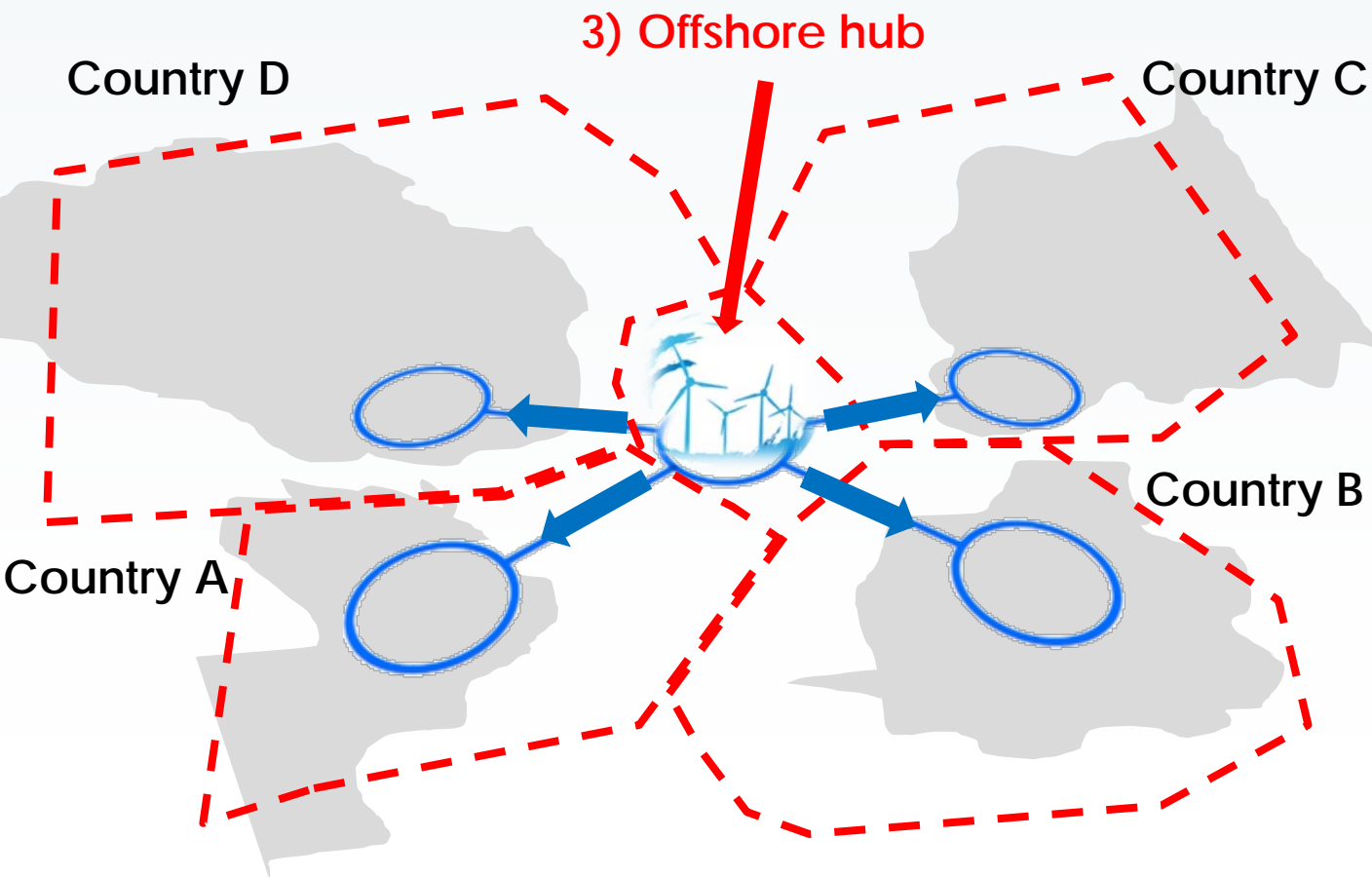
# Market access & Pricing rules: Option 2



## 2) Primary access

- Floating bidding zone
- Wind park can choose its bidding zone
- Production is integrated into the most attractive of the neighbouring countries
- RES support in all countries
- Residual inter-connector capacities dispatched by TSO

# Market access & Pricing rules: Option 3



## 3) Offshore hub

- Production of wind park forms its own market area
- No market choice for the wind park
- Joint RES support for the new market area
- All interconnector capacities dispatched by TSO

# Regulatory framework challenges

## Market integration and flexibility

### From passive to active dynamic generation / market actors

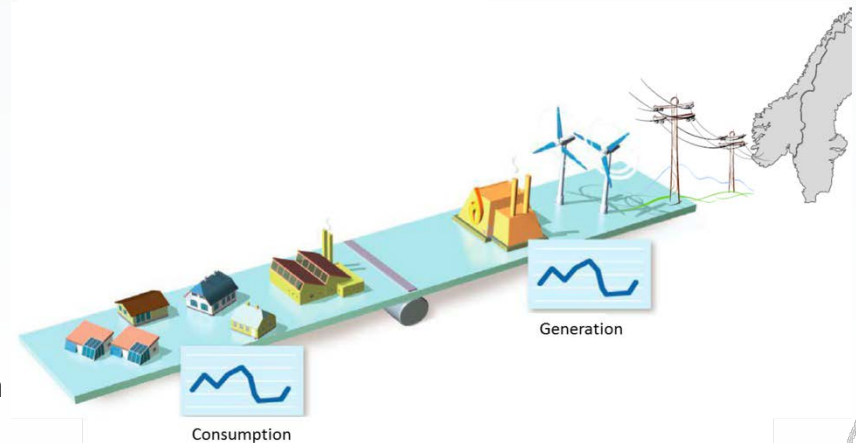
- Act to negative prices at the spot market (day-ahead)
  - Case: Change in market design from 2009: negative prices at NordPool
    - Close down of wind turbines in hours with neg prices = saved costs

- Active at the balancing markets
  - Close down of wind = down regulation

😊 **Case Denmark:** New wind turbines gets a Feed In Premium in certain full load hours (depending on size). When down-regulation, the not "used" full load hour with support can be used later.

😞 **Case Denmark:** Some existing off-shore tenders have no incitements for WTs to be active in down-regulation.

😊 One (Anholt) doesn't receive FIT when negative prices.



# Managing **Negative** Spot Prices

Case: Sund & Bælt wind farm – 16. March 2014

## Elsport prices ?

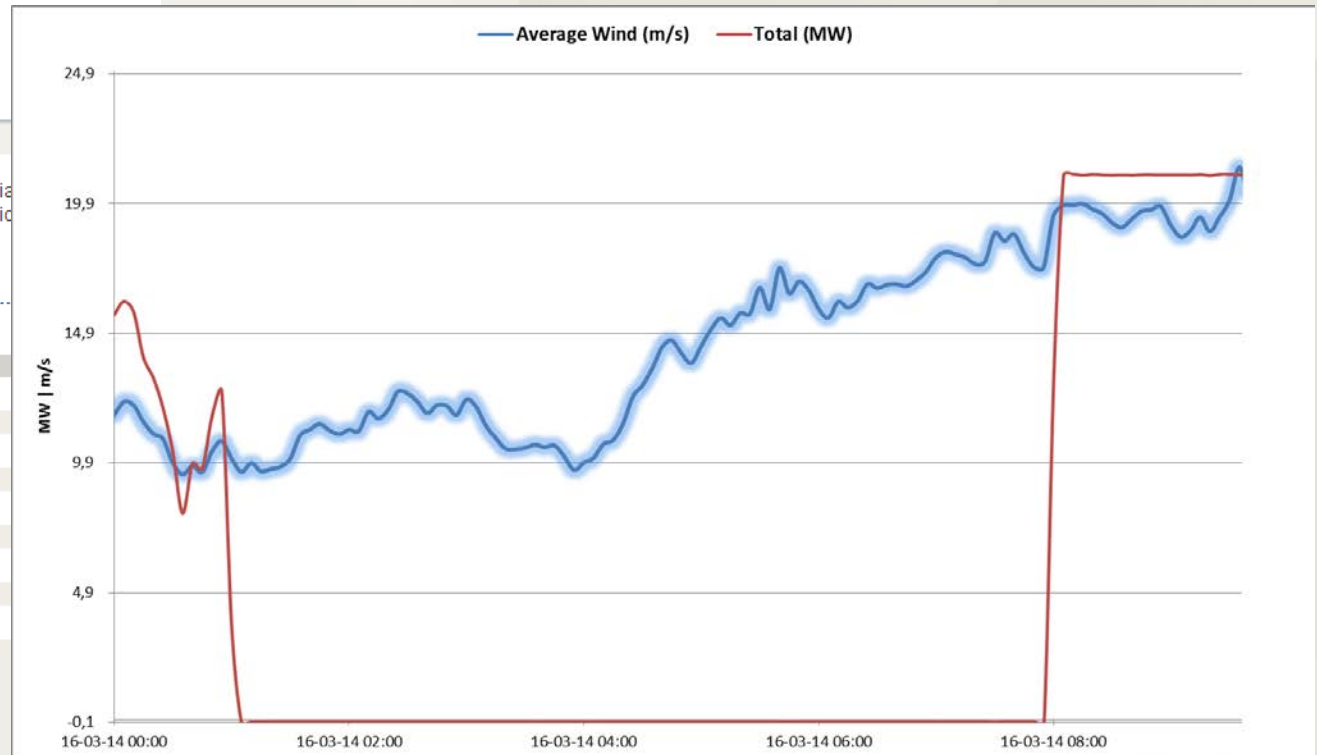
ALL SYS NO SE FI DK EE LT  
LV

- further details - ▼

Please note that changes in the Norwegian comparison between present and historic the [area change log pdf](#).

EUR/MWh

	DK1
16-03-2014	
00 - 01	-0,02
01 - 02	-25,08
02 - 03	-25,06
03 - 04	-60,26
04 - 05	-50,65
05 - 06	-50,12
06 - 07	-25,08
07 - 08	-25,00
08 - 09	0,05
09 - 10	10,77



# Managing **Negative** balancing Prices

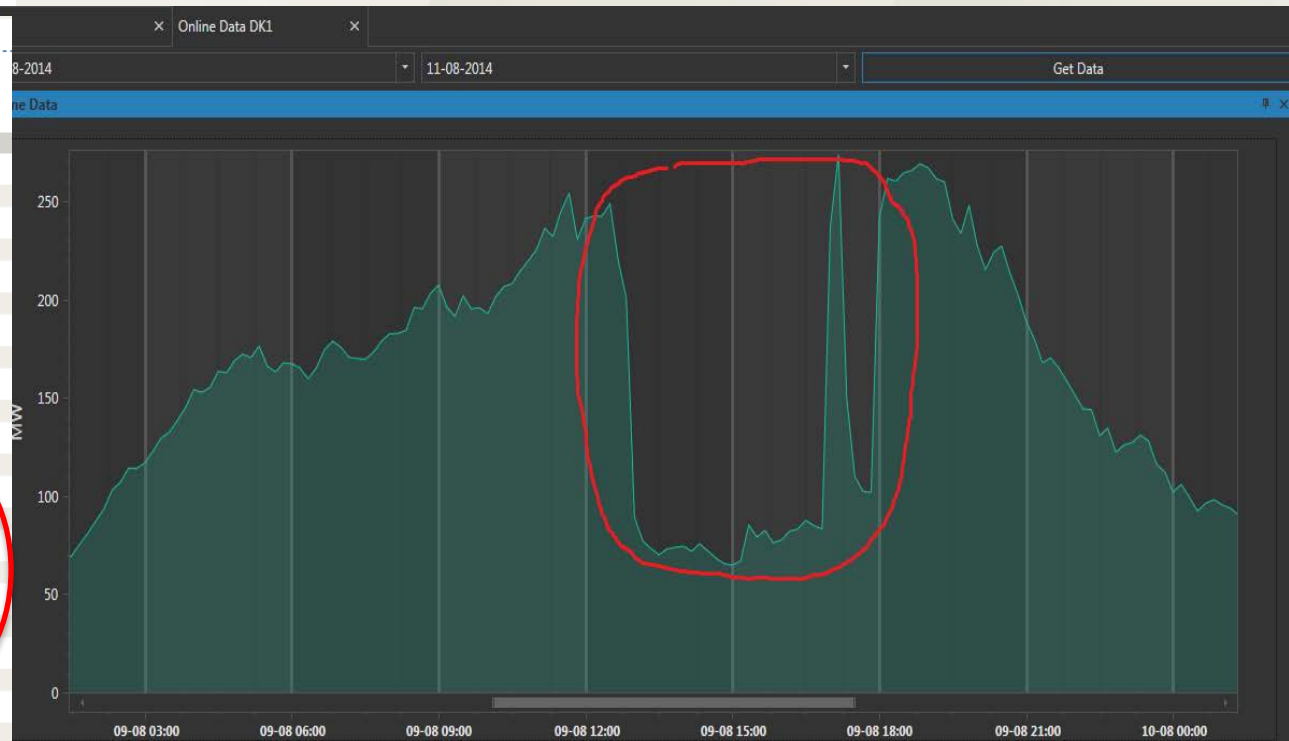
Case: Down ward regulation – 9 August 2014

## Regulating prices

ALL NO SE FI DK

DKK/MWh

	DK1	
	Up	Down
09-08-2014		
00 - 01	248,34	247,34
01 - 02	213,27	213,27
02 - 03	200,90	200,90
03 - 04	196,95	196,95
04 - 05	188,60	138,07
05 - 06	183,38	124,71
06 - 07	179,65	124,71
07 - 08	194,04	138,07
08 - 09	200,15	151,43
09 - 10	204,25	178,16
10 - 11	207,91	178,16
11 - 12	207,31	178,16
12 - 13	200,68	-90,00
13 - 14	189,05	-90,00
14 - 15	186,06	-541,94
15 - 16	200,75	-90,00
16 - 17	200,82	-90,00
17 - 18	191,88	-90,00
18 - 19	225,42	-50,00
19 - 20	240,26	155,86
20 - 21	246,22	182,70
21 - 22	249,20	193,82



# Discussion: future challenges

## ■ Main future challenges?

- Current challenges?
- Research gaps?
- Scope ?

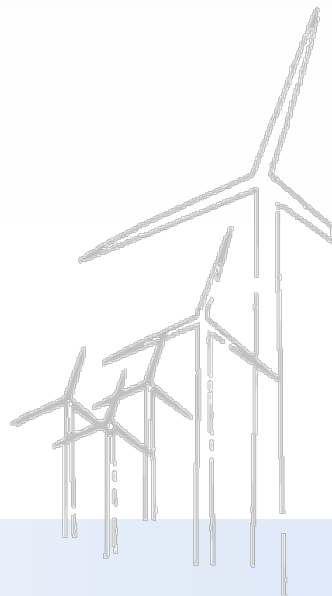
## Regulatory re-thinking

### ■ Wind farms at meshed offshore grids

- Bidding zones, congestion and residual transmission capacity
- Pricing rules? Support and burden sharing

### ■ Market Design:

- From passive to active dynamic generation / market actors. Value of ancillary services



Thank you for your  
interest



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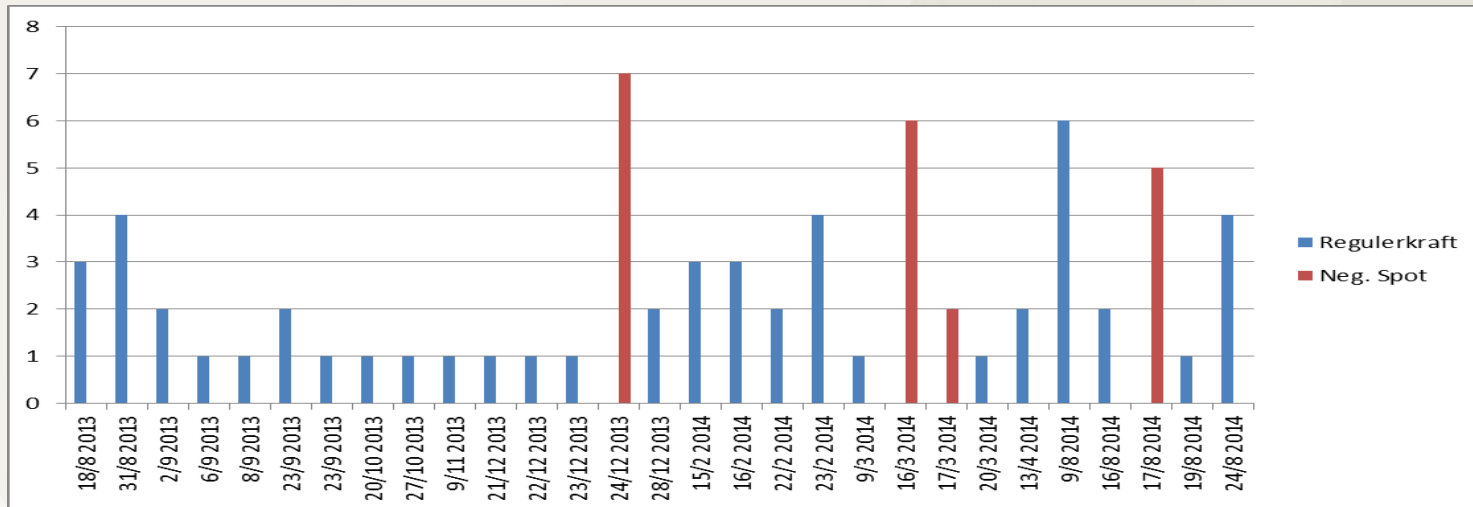
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# Questions ?





# Last year with active participation of wind turbines in ancillary service

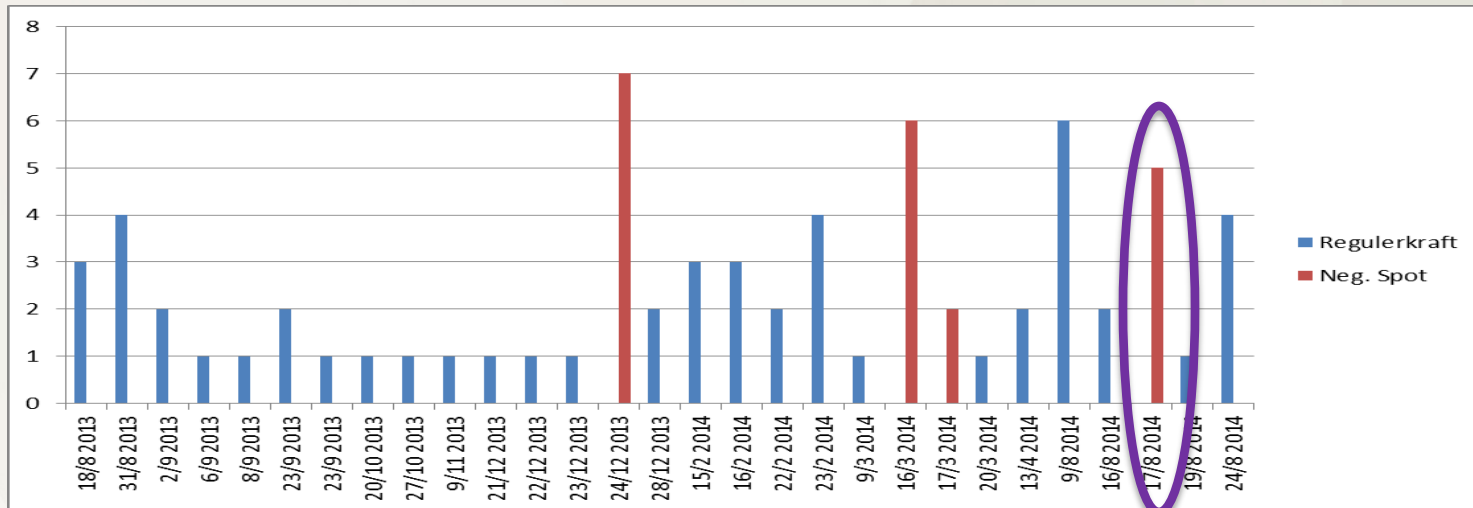


Activations where negative regulating prices are below -50 DKK/MWh.

- 25 times
- 51 hours

Last year with active participation of wind turbines in Day Ahead market.

Hours



Protection against negative spot prices 17. august 2014.

- Day Ahead trading resulted in negative spot prices
  - Wind production was expected at high level
  - Wind production considerable lower than expected
  - Wind turbines were used actively and did not stop at all.